PATENT SPECIFICATION

Convention Date (Germany) : June 22, 1926. **273,306**

Application Date (In United Kingdom): June 22, 1927. No. 16,692/27.

Complete Accepted: Nov. 10, 1927.

COMPLETE SPECIFICATION.

Improved Manufacture of Plates or Walls of Vessels to be Heated or Cooled by Passage of Fluid through Tubes.

I, RICHARD SAMESREUTHER, a German citizen, of Hochweiselerstrasse, Butzbach, Hessen, Germany, do herebydeclare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Plates or walls of vessels which are to be heated or cooled by passage of fluid through tubes carried thereby, have been made by embedding tubes in a cast iron plate during the casting operation. Since one side at least of the plate produced must be smooth a very thick plate is formed which is in itself objectionable in many cases. Moreover, cast iron is not a satisfactory material both because it has little resistance to chemical action and is not adapted to withstand high pressure.

According to this invention such tubular plates or walls are made by welding tubes on the outer surface of a metal plate or metal vessel. This mode of construction has sundry advantages as compared with the use of cast iron in the manner described above. The possibility of welding the tubes to the plate or to the body of the vessel does not depend on the metal of which the plate or body consists, so that most suitable metal may be used in each case. The thickness of the plate or body may be selected merely from the point of view of construction. Furthermore tubular walls made by this method may have any desired shape, and the tubes may be of various forms besides rectilinear (such as coils, helices or grates) and of any desired diameter. Repairs and alterations are easily made. Transference of heat through the plate or wall is improved since welding can produce a closer union of the parts than is obtainable by casting iron around tubes.

The tubes may be welded to the surface which is to carry them by any of the known methods. For welding the so-called Perkins tubes or steel tubes to a metal wall which does not have the character of ingot iron or mild steel (for instance cast iron, nickel, copper-nickel bronzes or the like) there may be used as welding skelp wires appropriate for the temperature of the welding and adapted to ensure an intimate union with the tubes of the said surface.

The accompanying drawings illustrate the invention:—

Fig. 1 is a cross section through a tube wall made according to the invention and Fig. 2 is a like view of a modification.

a represents the wall and *b* the tubes welded to the outer surface thereof.

The welding operation (electric welding or autogenous welding) with the aid of the skelp produces a layer *c* in which the tubes are partly embedded. It is preferable that the layers should be such that the entire half of the external surfaces of the tubes adjacent to the wall is embedded in the layer.

In Fig. 2 the tube wall is lagged by insulating material *d* held in place by a sheet iron jacket *f*.

Having now particularly described and ascertained the nature of my said

invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A manufacture of plates or walls of vessels which are to be heated or cooled by passage of fluid through tubes carried thereby, by welding tubes on one side of the plate or wall, substantially as described.

2. Plates or walls of vessels having welded to a surface thereof tubes adapted for the passage of heating or cooling fluid.

Dated this 22nd day of June, 1927.

ABEL & IMRAY,
30, Southampton Buildings, London, W.C. 2,
Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1927.

FIG. 1.

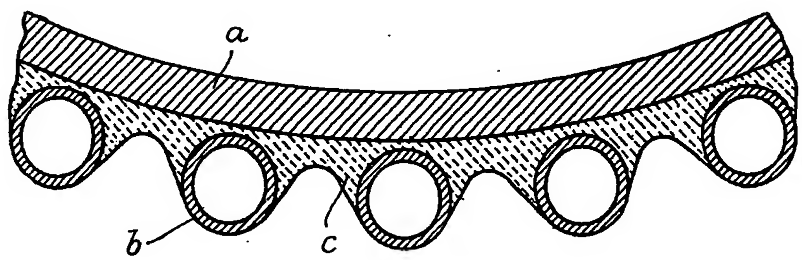
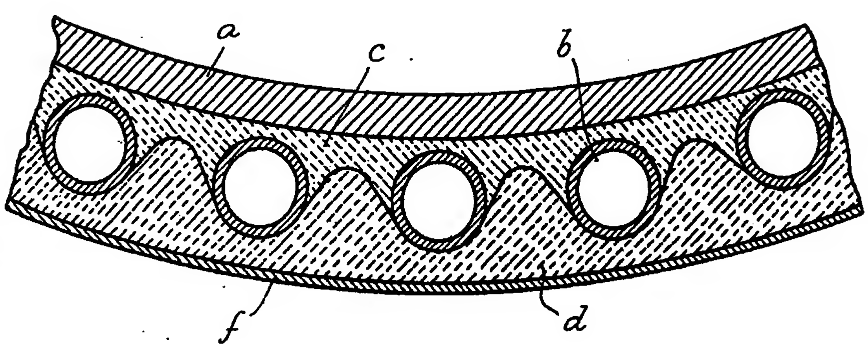


FIG. 2.



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PATENT SPECIFICATION

Application Date: Aug. 14, 1933. No. 22679/33. **424,063**

Complete Specification Accepted: Feb. 14, 1935.

COMPLETE SPECIFICATION

Improvements in or relating to Heat Conducting Tubes

(A Communication from abroad by METROPOLITAN ENGINEERING COMPANY, a corporation of the State of New York, United States of America, located and doing business at No. 1250 Atlantic Avenue, Brooklyn, New York, United States of America.)

I, REGINALD EATON ELLIS, of the Firm of Mewburn, Ellis & Company, Chartered Patent Agents, of 70 & 72, Chancery Lane, London, W.C.2, British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to furnace heat conducting tubes of the type having metallic projections or members welded to the tube and radially disposed on opposite sides of the tube.

In a previous United States Patent No. 1,844,407, granted February 2, 1932, there is described a wall for boilers or heaters made of tubes having flanges extending lengthwise thereto, so as to provide an extended heating surface exposed to the heating gases.

We are aware that studs have also been employed, as for example in a prior British Patent No. 386,916.

The present invention provides an improvement thereon in which, instead of a continuous long flange or studs, there is used a series of projections or fins of short length in a direction parallel to the axis of the tube. The term "length" is used herein to designate the dimension lengthwise of the tube, and the term "width" to designate the dimension transverse to the axis of the tube. The boiler units of the present invention are designated particularly as a substitute for those of the aforesaid United States patent. However, they may be used in various other apparatus in which tubes are provided through which water is heated and circulated, or steam is super-heated and circulated, or in which gases or other fluids are heated and circulated.

Now in accordance with this invention I provide a tube of the type described for the heating and circulatng of water or other fluid, said tube having a series of numerous separate projections consisting mainly of flat fin like surfaces forming extended heating surfaces, each being united directly to said tube by a separate electric resistance weld providing a continuous homogeneous metallic path for conducting heat, each weld having an area small enough to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperature, and the projections being applied over substantially the entire exposed length of the tube and having their outer ends free so that they can expand separately under heat, whereby the unit is adapted to stand exposure to high temperatures without injury and the projections are proof against burning away at ends remote from the tube.

The accompanying drawings illustrate embodiments of the invention.

Figs. 1 and 2 are respectively a horizontal section and an upper part of an inside elevation of the side wall of a boiler built with the tubular units of the invention; Fig. 3 is a diagram illustrating a method of production of the flanged tubes; Figs. 4, 5 and 6 are plans of various forms of unit made in accordance with the invention; Fig. 7 is a side elevation of the upper end of one of the units; Fig. 8 is a horizontal section of a further modification; and Fig. 9 is a vertical section thereof; Fig. 10 is a vertical section of a further modification.

Referring to Fig. 1, the boiler wall is made with an inner lining or screen comprising tubes 1 with lateral flanges 2 of oblong cross section extending across the spaces between the tubes and overlapping each other so as to form a baffle between them. The flanges 2 have their longer axis of their cross section parallel to the axis of the tubes 1 the outside of this screen is the wall of the boiler structure which may be of any usual or suitable material and which as illustrated comprises refractory blocks or bricks 3 out-

side of which are tiles 4 of non-conducting material and an outer shell 5 of sheet metal. The longitudinal fins extend throughout such portions of the length of the tubes as may be desired according to the design of the boiler and preferably throughout the zone of radiant heat where their conducting effect is of greatest value. As shown in Fig. 2, they extend substantially up to a header 6 into which the upper ends of the tubes are introduced, leaving the tubes without flanges for a sufficient length to facilitate the making of the joints with the header. The flanges may extend clear down to a similar header below; or may be omitted at the lower end where their cooling effect on the fire bed might be objectionable as illustrated, for example, in the British Patent No. 225,810 of June 11, 1924, and illustrating a boiler wall made with such tubes.

The fins on the tubes serve to transmit heat to the tubes and the water or other fluid therein, and also to protect the masonry or other backing of the wall from the heat of the flame. There is naturally a considerable expansion of the metal by the heat and it varies at different points in the wall. The flanges therefore, while they preferably close the spaces between the tubes by overlapping at their edges, are not secured together but are free to permit relative movement and also to facilitate the repair of the wall in case one or more of the tubes or flanges may be damaged. To conduct the heat more efficiently to the tubes, and to prevent their partial separation from the tubes under the distortion produced by the high temperature, the flanges should make as strong a connection as possible to the tubes and the area of the connection should be fully equal to the section of the flanges. For this purpose we propose to weld the edges to the tubes and to provide a welded area at least equal to and preferably greater than that of the longitudinal section of the flanges.

In Fig. 3 there is illustrated a suitable method of butt-welding a simple projection or flange member by an electric resistance welding method, which may be a commonly called flash-welding method, or which may consist in passing a current of extremely high ampere strength for a very brief regulated period of time through the parts which are in contact while they are pressed together.

The tube 1 is clamped between a pair of positive electrodes 10. The plate 2 is clamped into negative electrodes 11. The plate has its edge which is in contact with the tube slightly beveled. The welding current is passed as explained and the parts are welded firmly with a take-up sufficient to bring the joint to a greater thickness than that of the plate, as shown at 7 in Fig. 4.

Figs. 4 to 6 show a single flange on each tube, and the invention may be applied in this way with the single flange arranged to extend over all or any desired part of the space between two tubes. But, for a given spacing of the tubes, a flange on each side is preferable since it does not have to be so wide as a single flange would and since it provides a shorter distance for conduction of heat through the flange to the tube. Also, instead of making the flanges as in Fig. 1 so wide as to overlap, they may be made of less width and arranged to contact or even to leave a space between their adjacent edges. Also, besides the side flanges illustrated, there may be one or more flanges arranged along the front of each tube, that is, the side of it which is exposed to the furnace gases in order to provide a larger heating surface; and one or more flanges arranged at the back of each tube for connection to the outer part of the wall and for other purposes.

The construction above described is covered in Patent No. 1,844,407, above referred to. According to the present application the flanges, or one or more of them where a plurality of flanges is employed, are interrupted at intervals in their length. This is particularly advantageous for units of considerable length such as are required in modern high duty boilers, for example. The interrupted construction serves a greater convenience in application of the flange to the tube and is particularly important in that it permits distortion of the units without excessive strain on the welded joints.

The flanges may be of various shapes in cross section. There are a number of standard rolled shapes which are suitable, several of which are illustrated in the aforesaid patent. There are numerous others that are available.

In Fig. 4, the flange is a common rolled bar or strip of rectangular cross-section and of about the same thickness as the tube and is united by butt-welding at the joint 7. In the welding operation the root area may be increased as shown. The tube is assumed to be ordinary seamless boiler tubing. In Fig. 5, the flange 8 is made of a bar tapered in cross section with its wider edge butt-welded at 8^a. This is advantageous in that the increased width tends to com-

pensate for the increased amount of heat that the plate must carry as it approaches the tube and gives greater resistance against sidewise distortion strains at the joint.

In Fig. 6 the flange 2 is made of a bar similar to that in Fig. 4. Instead of butt-welding, however, the arc-welding method is applied to the joint. Metal 9 is deposited by the electric arc and welded to the flange and to the tube over areas which are at least equal to the longitudinal section of the flange and preferably greater to allow for any imperfections. This figure may be taken to illustrate also a butt-weld 7 as in Figs. 4 and 5, supplemented by the arc-welds 9.

A single tube may be used in making up each of the units, but the invention may be equally embodied in units provided with two or more tubes or passages.

The tubes may be ordinary seamless boiler tubing made of low carbon soft steel or they may be of lap-weld or butt-welded tubing. And, particularly where non-circular cross sections are desired they can be made of sheet metal lengths stamped into segments and welded together at their edges.

Tubes of the character described are generally of considerable length and of comparatively small diameter, the length being measured in feet and the outer diameter being a few inches, 3 to 5 inches in large installations. The wall thickness is slight compared with the diameter so as to effect a rapid transfer of heat.

The drawings illustrate tubes with a wall thickness about one-twelfth of the diameter. In practice boiler tubes are sometimes made even thinner. Standard four-inch boiler tubes have a wall thickness of one-fourth of an inch or less and the thickness is in increased proportion for larger tubes. The steel used for such tubes is of a certain composition designed to meet the pressures and strains of use and also to permit manufacture by piercing, drawing and rolling in the case of seamless tubes and bending and welding in the case of tubes made from skelp or strips.

The flanged tube of this invention is so constructed as to preserve the original strength and tightness of the tube against leakage under the prevailing conditions of internal pressure. With this aim, the construction is such as to maintain the wall of the tube intact.

The flange is a separate rolled strip or shape which does not involve any break in the continuity of the wall of the tube. The inner edge of the flange member is abutted against the continuous outer surface of the tube. The desired wall thickness is not reduced at any portion of its circumference.

The flanges and also the tubes may be made of ordinary rolled steel. But where they are to be subjected to very high temperatures it is advantageous to use a metal which is better adapted to resist deterioration by oxidation at such temperatures. A number of such metals are known largely alloys of iron with nickel, chromium and the like. There are also known methods of providing a surface or skin on steel which will resist oxidation, generally by impregnating the surface of the steel with some other metal or alloy. A good example of such a process is that known commercially as calorizing, in which the surface of the steel is given a thin but continuous and very adherent coating or impregnation of aluminium, which is partially alloyed with the steel. Under heat, the aluminium is oxidized, forming a thin continuous adherent coating of alumina which is very effective in resisting further oxidation. This method applies best to rolled steel, but is applicable to almost all other metals. Such a method has this advantage, that the body of the steel retains its original heat conductivity, which is greater than that of most of the resistant alloys of nickel or chromium.

The thickness of the flange should be increased toward the root roughly in proportion to its width in order to theoretically take care of the quantity of heat to be conducted. The actual extent and rate of such increase in thickness would vary with different conditions.

In some locations, particularly where the tube is to be embedded or otherwise firmly held, it is important to guard against buckling or similar distortion owing to the difference in the heating effect on the remote edge of the flange and also on the cooler wall of the tube. It has also been found that in the operation of welding, serious strains are set up in the completed unit which tend to warp it in use and even to break or crack the wall of the tube. A 20 foot tube has been found to suffer a decrease of approximately a quarter of an inch in its length in the welding of a continuous flange thereto. By making the flange in separate short pieces the strain is lessened and is distributed evenly throughout the length of the tube, both in the production and in the use of it.

According to the present invention these difficulties are avoided by interrupting the flange at intervals in its

length. Fig. 7 shows the flange 2, interrupted at intervals in its length by short spaces 12, extending all the way to the tube. Or such separation of the adjacent parts of the flange may exist for a part of its width, extending inward from the edge sufficiently to meet the circumstances.

Each of the flanges or pieces 2 may be of any of the shapes in cross-section above referred to and may be applied by any of the methods above described.

The separate flange members of Fig. 7 may be varied in length (that is, the general direction of the length of the tube) and in the spacing between adjacent members. Satisfactory proportions are shown in Fig. 7 taken in connection with the plan views; the members being in the form of small plates of about the same thickness as the tube wall, of a length about equal to their width or slightly less and of a spacing about equal to their thickness or less.

Electric resistance welding operations of this type are important in order to produce a continuous homogeneous metallic path for conducting the heat from the projection to the tube; that is, a path in which there is no interruption of the continuity and homogeneity of the conducting metal. At the same time resistance welding operations pass the current through the parts to be welded and heat them to a considerable degree. It is this heating of the metal of the tube particularly which sets up the strains referred to hereinabove, and it is for units made by this particular welding method that the present invention has its greatest advantage.

Not only is the tube apt to be distorted by the welding temperature, but also the projection. Such distortion, or tendency to distort, sets up internal strains in the projections. Metal under such internal strain is more readily oxidized than metal in which there is no such strain.

With the comparatively small cross-section projections illustrated herein, there are no substantial internal strains set up. Consequently they may be made to extend to a much greater width or radial distance from the tubes than where flanges or projections are used of such a size as to be internally strained during the welding operation.

In the present invention the radial dimension of the projections may be determined in adavnce on the assumption that the metal is not strained substantially and the ends of these projections may be extended to a considerable distance and still be proof against burning away; though with a continuous flange of any substantial length in the axial direction they would not be so.

With the continuous fins of my prior patents, the strains induced by the welding operation have been so great that it has not been safe to cut away any portion of a fin at one side only of a tube, because of the strains on the other side. Nevertheless openings through the fins are desirable for peep holes, air passages or the like. This disadvantage is obviated by the present invention.

With the use of separate projections, as in the present unit, one or more of these may be omitted at one side without danger of injury or excessive distortion arising from the provision of projections on the opposite side.

Fig. 8 is a view illustrating a plurality of tubes 1 arranged in staggered relationship and communicating with common header 24. Radial extensions 25 are welded to the several tubes. As shown in Fig. 9 these extension members are in the form of rods which have been flattened as indicated so as to dispose relatively wide surfaces 26 in a horizontal plane. The shank portions 27, of the members are of cylindrical or rod-like form and are welded electrically to the wall of the tube, as shown in Fig. 9.

Instead of disposing the flat surface 26 in a horizontal plane they may be disposed in a vertical plane as shown in Fig. 10. The arrangement of Fig. 10 will substantially or approximately close the spaces between adjacent members 25 as shown and when the ends of adjacent members 25 come into substantial abutment, as shown at 28 in Fig. 8, the members 25 will in effect form a substantially closed wall.

The length of the welded joint parallel to the axis of the tube is so short as to avoid transmitting destructive heat-distortion strains to the tube at the point of connection.

The extension members should be spaced close to each other to secure the maximum absorption of heat and transmission thereof to the tubes. For this purpose the space between the bases of these members should, for maximum effectiveness, be not much more than the length of the welded joint.

It is desirable in many structures to make projections extend to a great distance from the tube. It has been thought heretofore that such distance be limited only by conductivity of the metal and the temperatures applied. I have found, however, that there are two further important considerations. If the joint does not provide a sufficient path

to take the heat away, the high temperature of the rod will burn out its ends; also if the projection is under any internal stresses, it will be burned away more readily than if it were not so strained. By using an electric resistance weld, a practically perfect path is provided for the transmission of heat between the projection and the tube. But, as such a weld involves heating the parts to a high temperature, we reduce the size of the projections to such a dimension that it will not be put under any strain in performing the welding operation. By this combination we have greatly increased the distance to which the projections can be carried beyond the tube and still be proof against being burned off.

Also it has been found that the welding of flanges to any substantial length to the tubes as in the aforesaid patent, sets up very serious contractile stresses within the tube wall which are liable to rupture it under the strains of use; and such stresses are eliminated or diminished to a negligible point by the localizing of the joints to as small a portion of the length of the tube as is practical.

Having now particularly described and ascertained the nature of the said invention as communicated to me from abroad, and in what manner the same is to be performed, I declare that what I claim is:—

1. A tube of the type described for the heating and circulating of water or other fluid, said tube having a series of numerous separate projections consisting mainly of flat fin-like surfaces forming extended heating surfaces, each being united directly to said tube by a separate electric resistance weld providing a continuous homogeneous metallic path for conducting heat, each weld having an area small enough to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperatures, and the projections being applied over substantially the entire exposed length of the tube and having their outer ends free so that they can expand separately under heat, whereby the unit is adapted to stand exposure to high temperatures without injury and the projections are proof against burning away at ends remote from the tube.

2. In a boiler wall construction, a multiplicity of upright tubes according to claim 1 connected into the circulation of the boiler spaced apart from one another and connected at their ends, and metallic members extending substantially across the spaces between said tubes and consisting in each space of a series of comparatively small members separate from each other in heat conducting engagement with the tubes and slightly spaced apart so that they can expand separately under heat.

3. A boiler wall construction according to Claim 2, said metallic members comprising small projections welded separately to the tube, with their outer edges free.

4. A tube according to Claim 1, the projections being applied over substantially the entire exposed length of the tube and being spaced as closely to each other as is practicable without interference when heated.

5. A tube according to Claim 1, the projections being parallel with each other, and the series of projections being in a line parallel to the axis of the tube.

6. A tube according to Claim 1, the area of the homogeneous metallic heat-conducting path being so large in proportion to the width of the projection as to be sufficient to transfer to the tube the heat absorbing capacity of the projection, and being so small as to avoid inducing internal strain in the projection by the welding operation.

7. A process of producing tubes with extended area for exposure to heat as claimed in Claim 1, which consists in applying to the exterior of the tube numerous projections of a width (transverse to the axis) greater than the length (parallel to the axis) and greater than the lengthwise spaces between them, by welding the inner ends of the projections to the tubes by separate electric resistance welds providing a continuous homogeneous metallic path, each weld having an area so large in proportion to the length of the projection as to be sufficient to transfer to the tube the heat-absorbing capacity of the projection, and so small as to permit application of the projection without substantial strain upon or deformation of the tube and the projection by the welding operation or under subsequent exposure to high temperatures, so that the projections shall be proof against burning away at the ends remote from the tube.

8. A tube according to claim 1, the projections being in longitudinal alignment with each other and parallel with the axis of the tube and being separated from one another at short intervals.

9. A tube according to claim 1, the projections being in two groups opposite to each other and separated from each other by approximately half the circum-

ference of the tube, the circumference being bare between said opposite groups.

10. A tube according to claim 1, the projections being disposed in such manner as to provide a substantial unbroken furnace chamber wall when used in combination with other similarly arranged tubes.

11. A tube according to claim 1, with the projections applied thereto as described, the tube being a long steel tube of the order of four inches diameter and of small wall thickness compared to its diameter.

12. A tube according to claims 1 or 4 to 7 in which the projections have their longer transverse axes parallel to the axis of the tube.

13. A tube according to any of claims 1 or 4 to 7 in which the projections have their shorter transverse axes parallel to the axis of the tube.

14. A tube with flanged members or projections and each of the several variants thereof, each substantially as herein described and illustrated.

Dated this 14th day of August, 1933.

MEWBURN ELLIS & CO.,
70 & 72, Chancery Lane, London, W.C.2.
Chartered Patent Agents.

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Fig. 1.

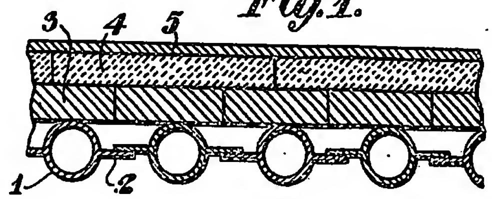


Fig. 2.

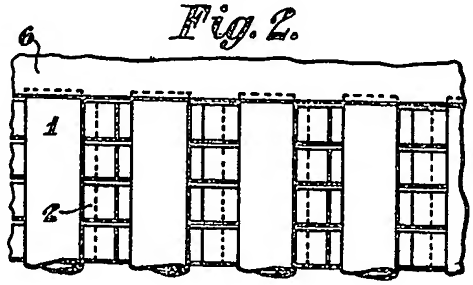


Fig. 3.

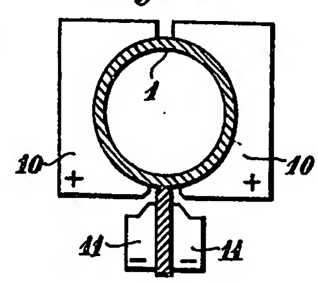


Fig. 4.

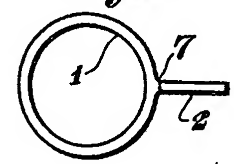


Fig. 5.

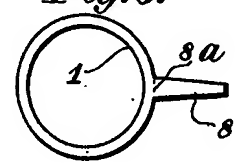


Fig. 6.

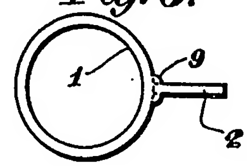


Fig. 7.

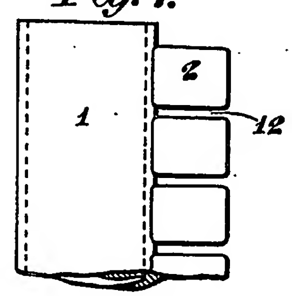


Fig. 8.

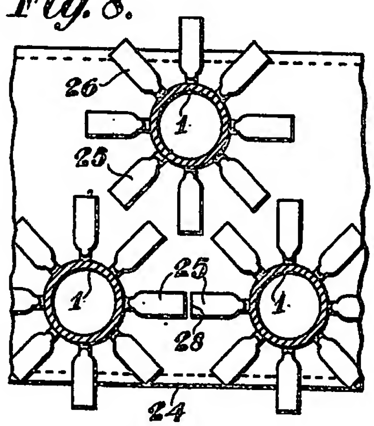


Fig. 9.

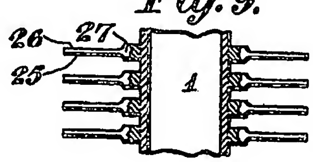
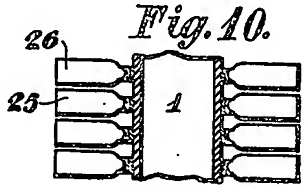


Fig. 10.



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